Soil Characteristics and Wind Erodibility: Summary of Results from Final Report

Vic Etyemezian

Desert Research Institute

- Co-authors: Mark Sweeney, Eric MacDonald, Todd Caldwell, John Gillies, George Nikolich, Jin Xu, William Nickling, and Torin Macpherson
- Reviewers: DWR, USGS, GBAPCD, CH2M Hill, DRI

Study Goal/Approach

- Understand and quantify PM_{10} dust emissions from future exposed “playa”
- Use observations/measurements from currently exposed shoreline
- Methods
  - Conduct on-site wind erodibility/emissivity measurements
    - PI-SWERL
  - Collect and analyze bulk soil properties
    - salt content, bulk density, soil texture, chemistry, moisture content
  - Document surface crusting conditions by time of year
    - spring penetrometer, cone penetrometer, qualitative description
  - Quantify spatial and temporal distribution
    - 3 field campaigns – September 05, January 06, March 06
    - 12 – 16 sites

Sites

- Grouped by Landform:
  - "Paleo-lake", "Playa-like", "Barnacle beach", "Dry wash", and "Inter-dune"
    - "Paleo-Lake": Sediment from Ancient Lake Cahuilla
      - Silt/clay crusts
      - Some 1-3 mm snail shell deposits
      - Low Salt content (< 10,000 mg/kg)
      - 2 sites: A101, A31
    - Interdune
      - Sandy loam
      - Very low salt
      - 1 site: SS6

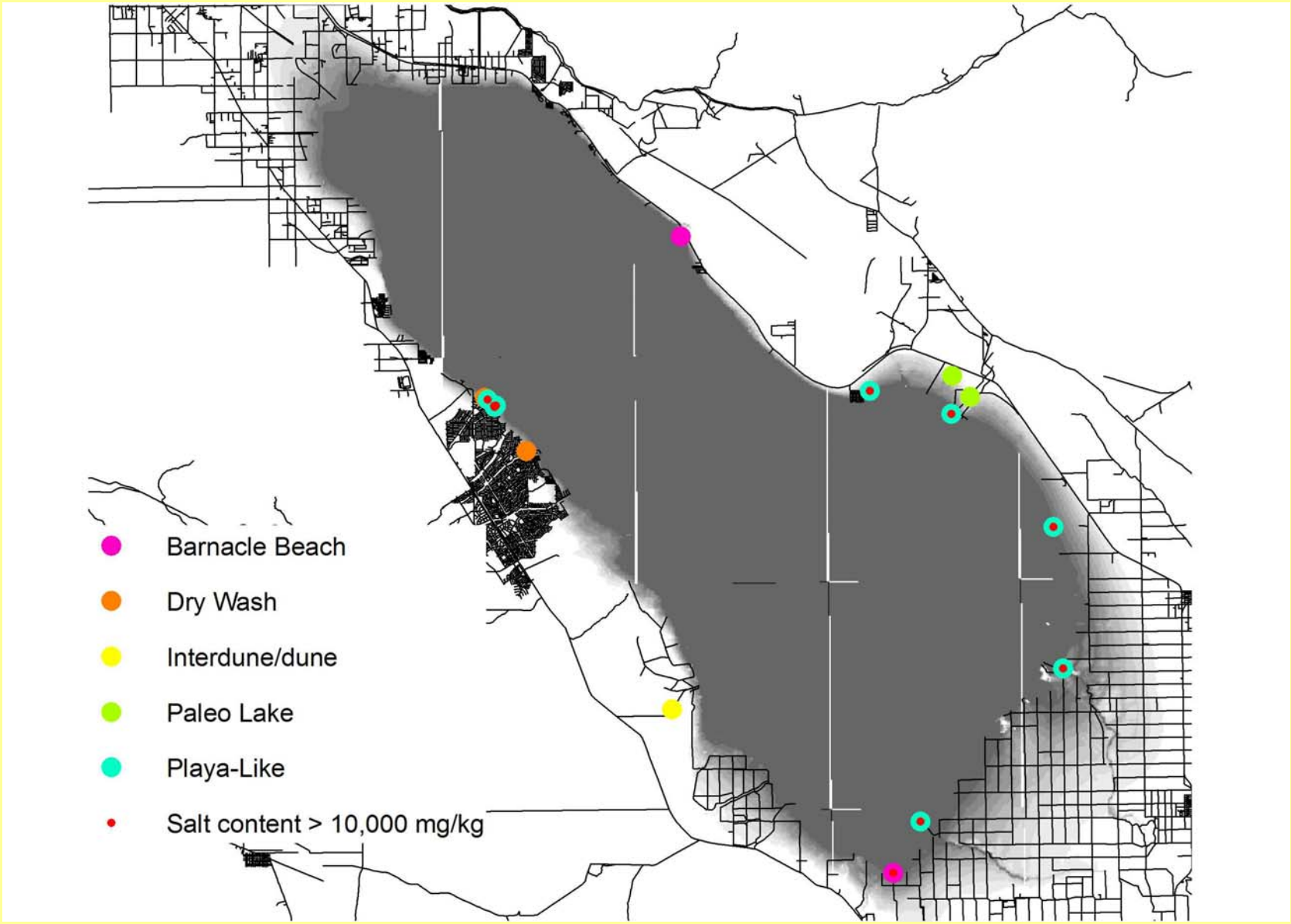
Sites

- "Playa-like"
  - Assumed to most closely resemble sediments when initially exposed as water recedes
  - Generally silt/clay or silt/loam
  - Salt content high (>10,000 mg/kg – often > 50,000)
  - 9 sites: A100-2, A200, A201, A32, A34-1, A34-2, SS16, SS17, SS23
- "Barnacle beach"
  - Low-moderate salt
  - Texture is coarse with barnacles
  - 2 sites: A29, SS9

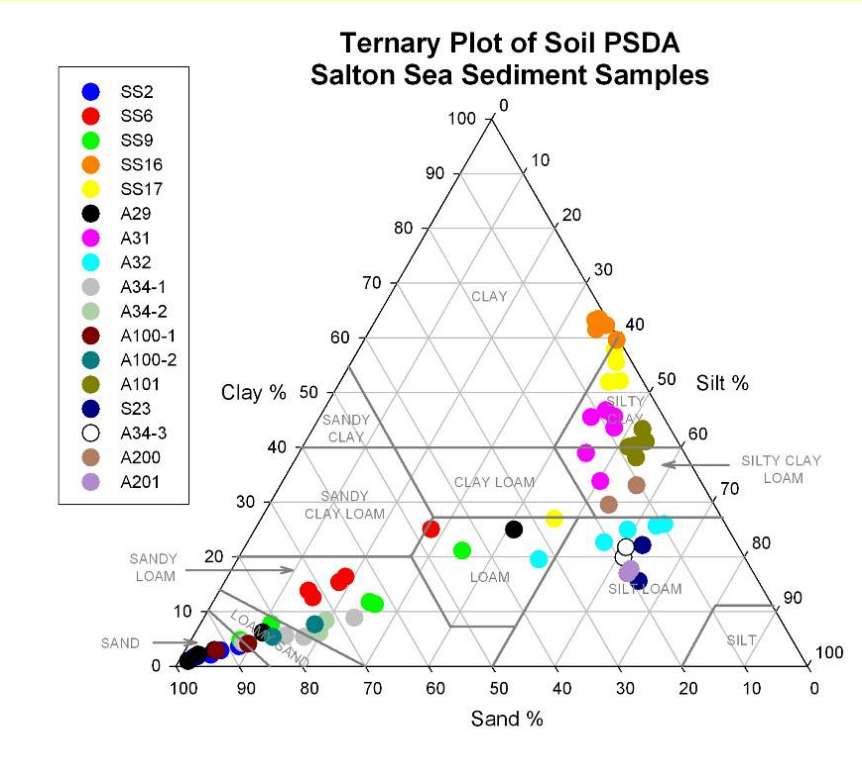
Sites

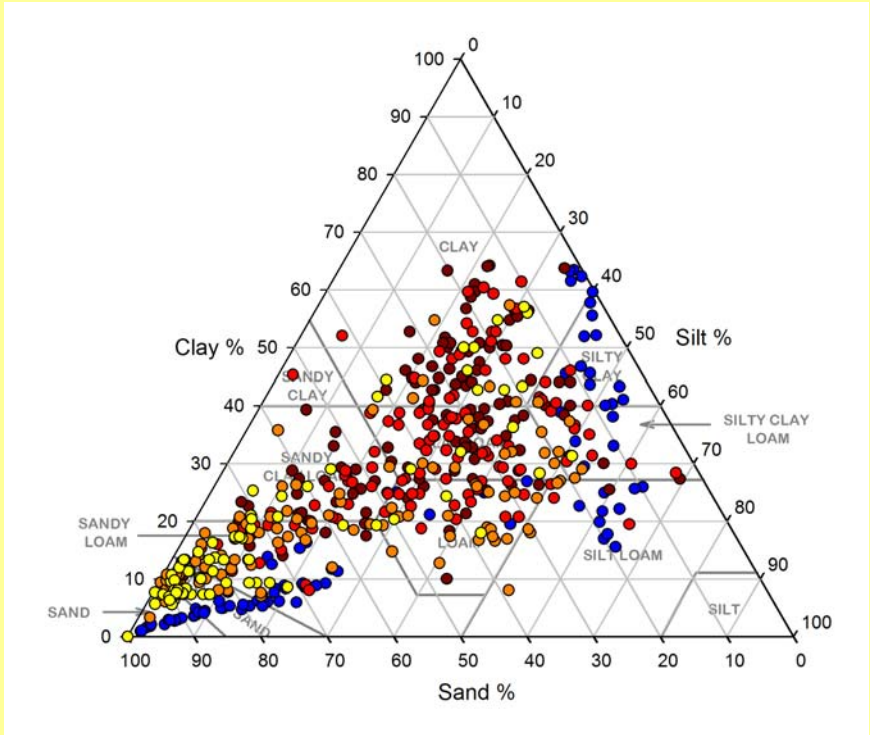
- “Dry wash”
  - Sandy texture
  - Low salt
  - 2 sites: A100-1, SS2

Sites


Barnacle Beach
Dry Wash
Interdune/dune
Paleo Lake
Playa-Like
Salt content > 10,000 mg/kg

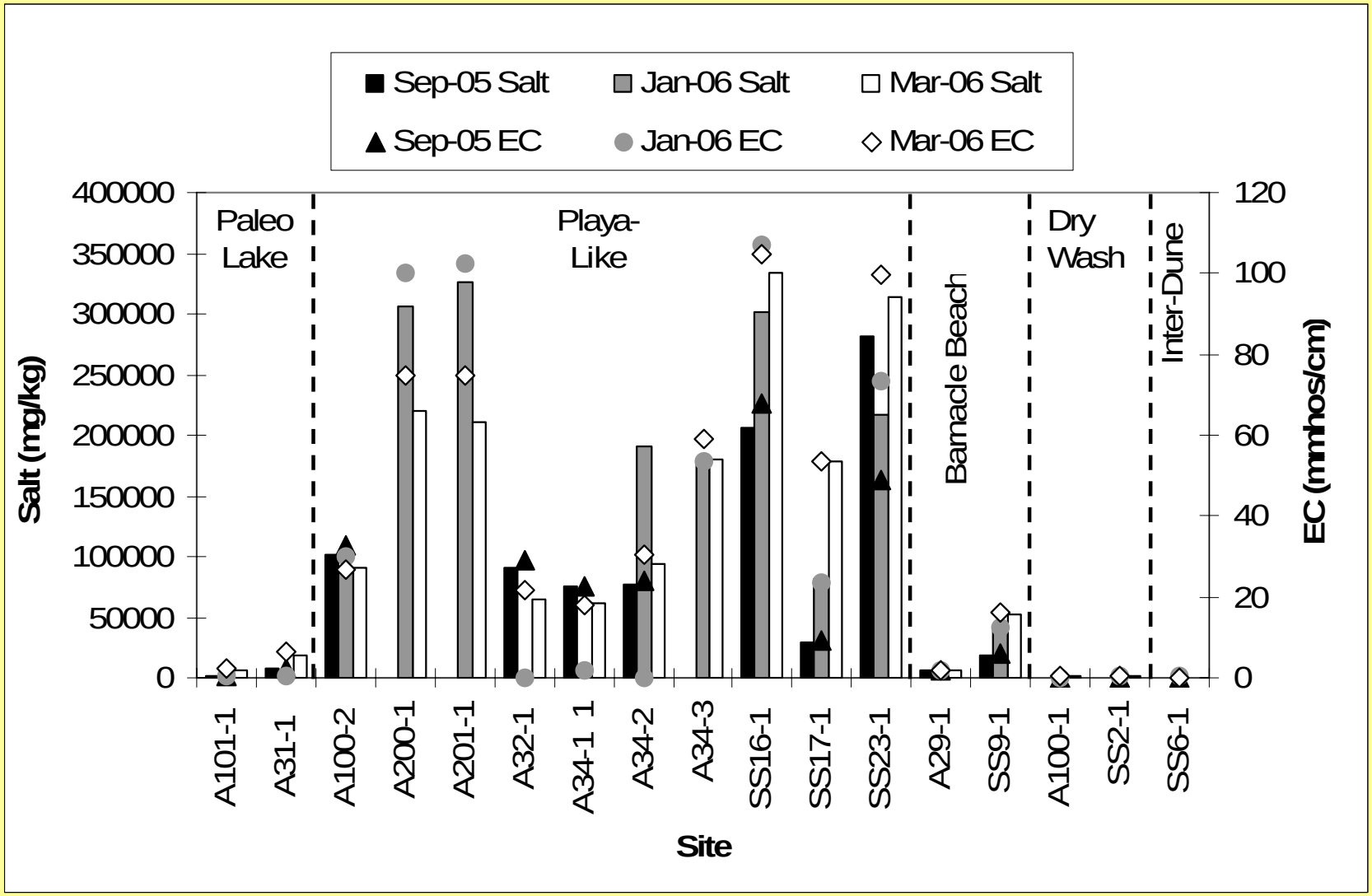
Textures covered



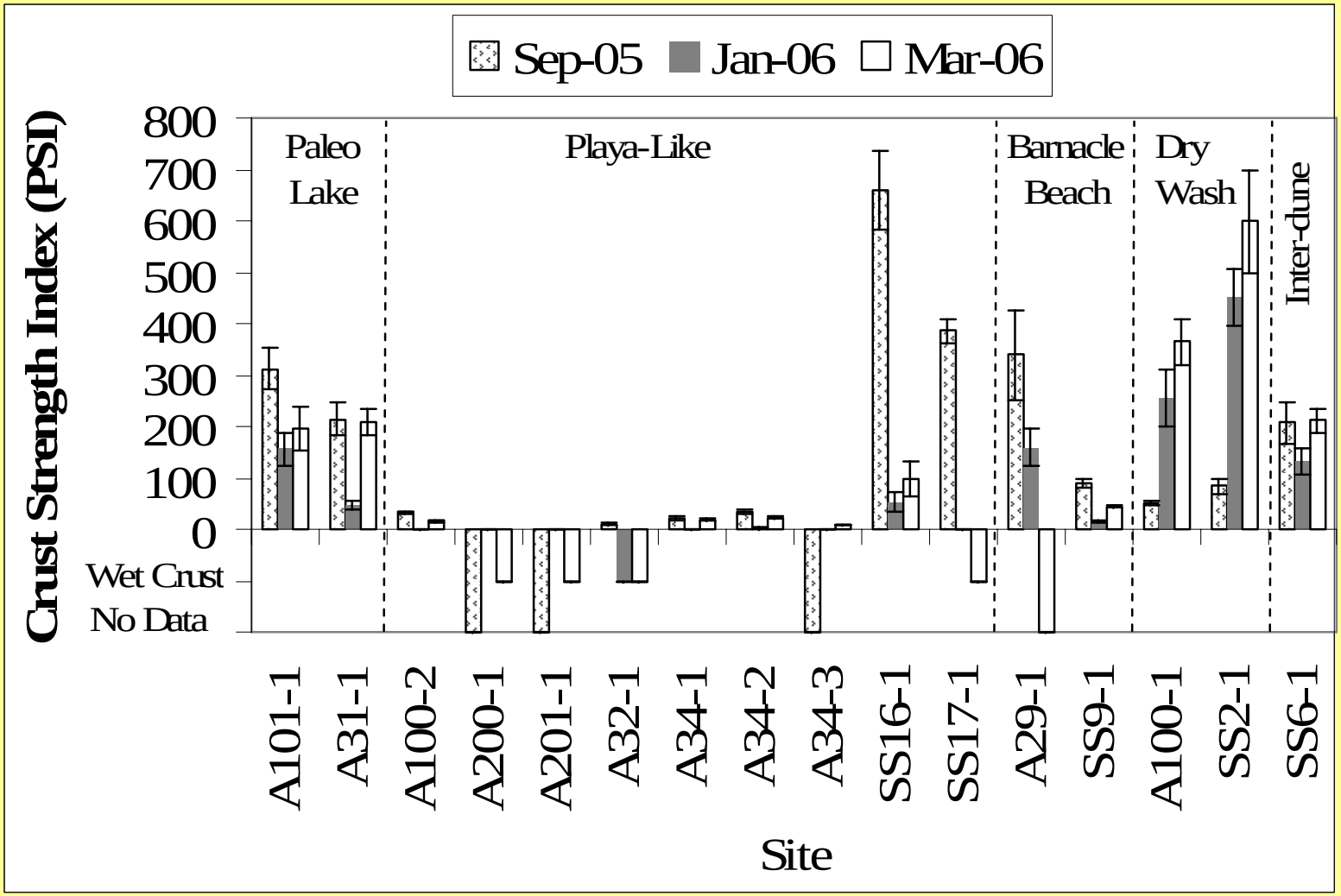


Source: Agrarian Research, 2003

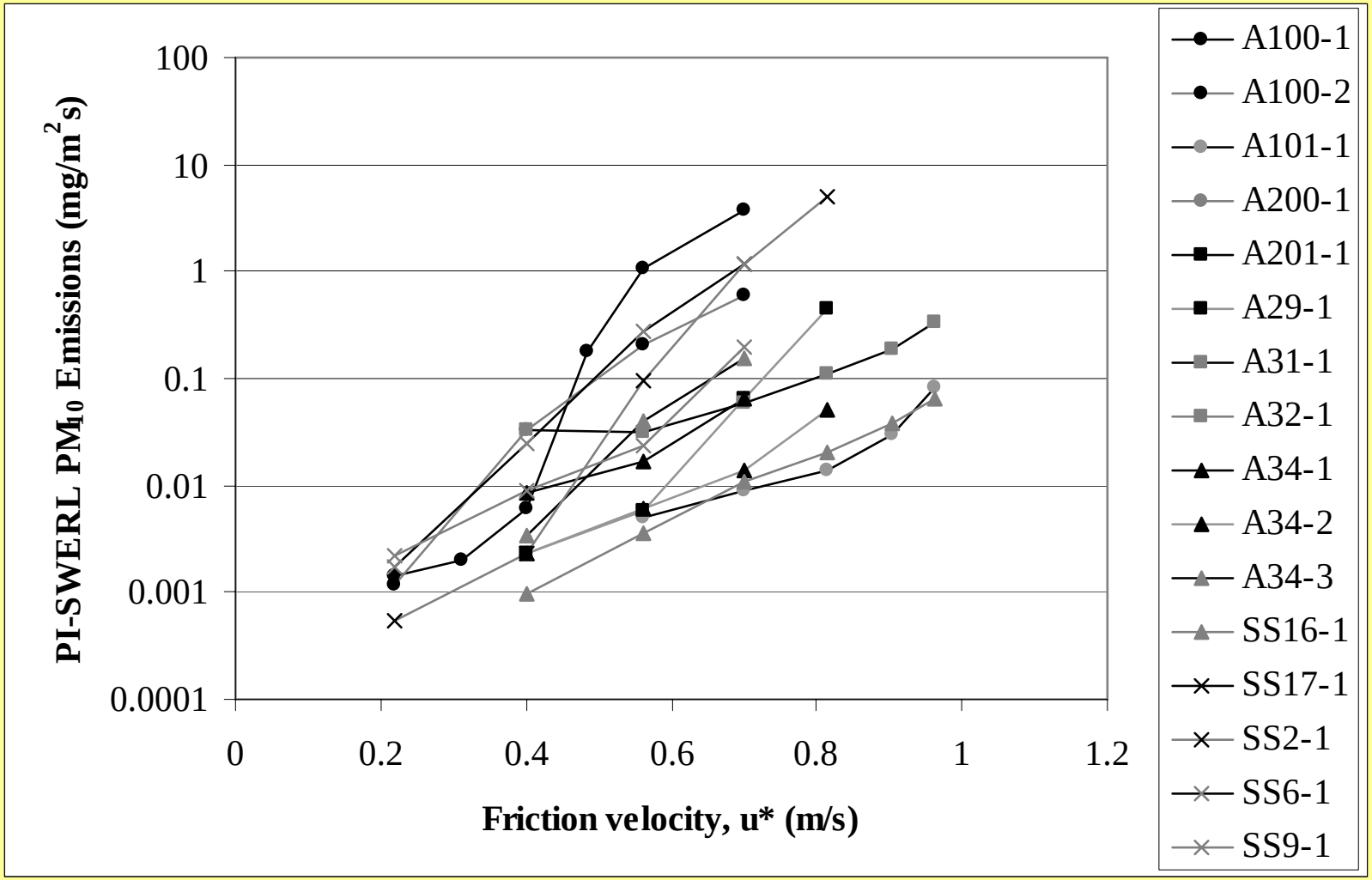
Salt by Landform



Crust properties: Spring penetrometer



PM_{10} Emissions

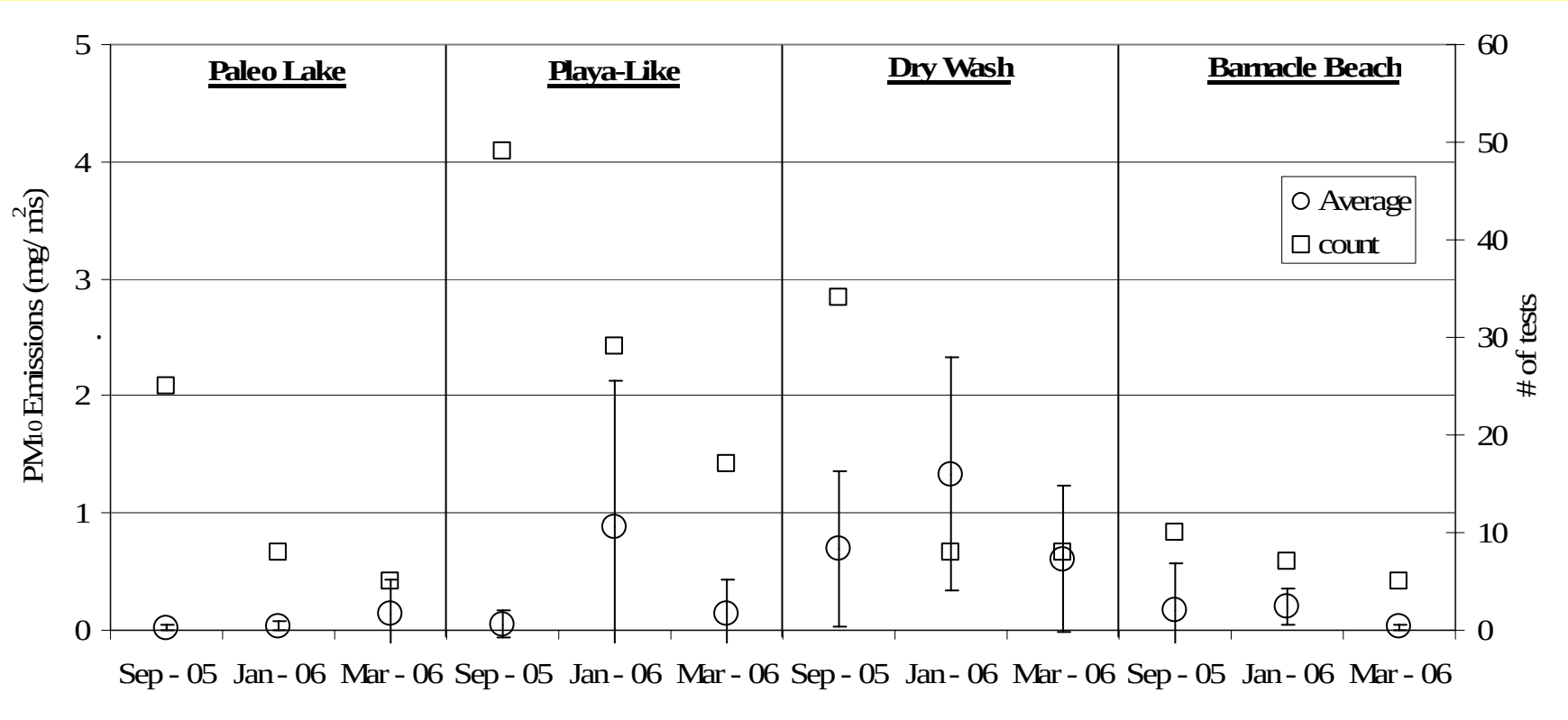


Friction Velocity Depends on z_0

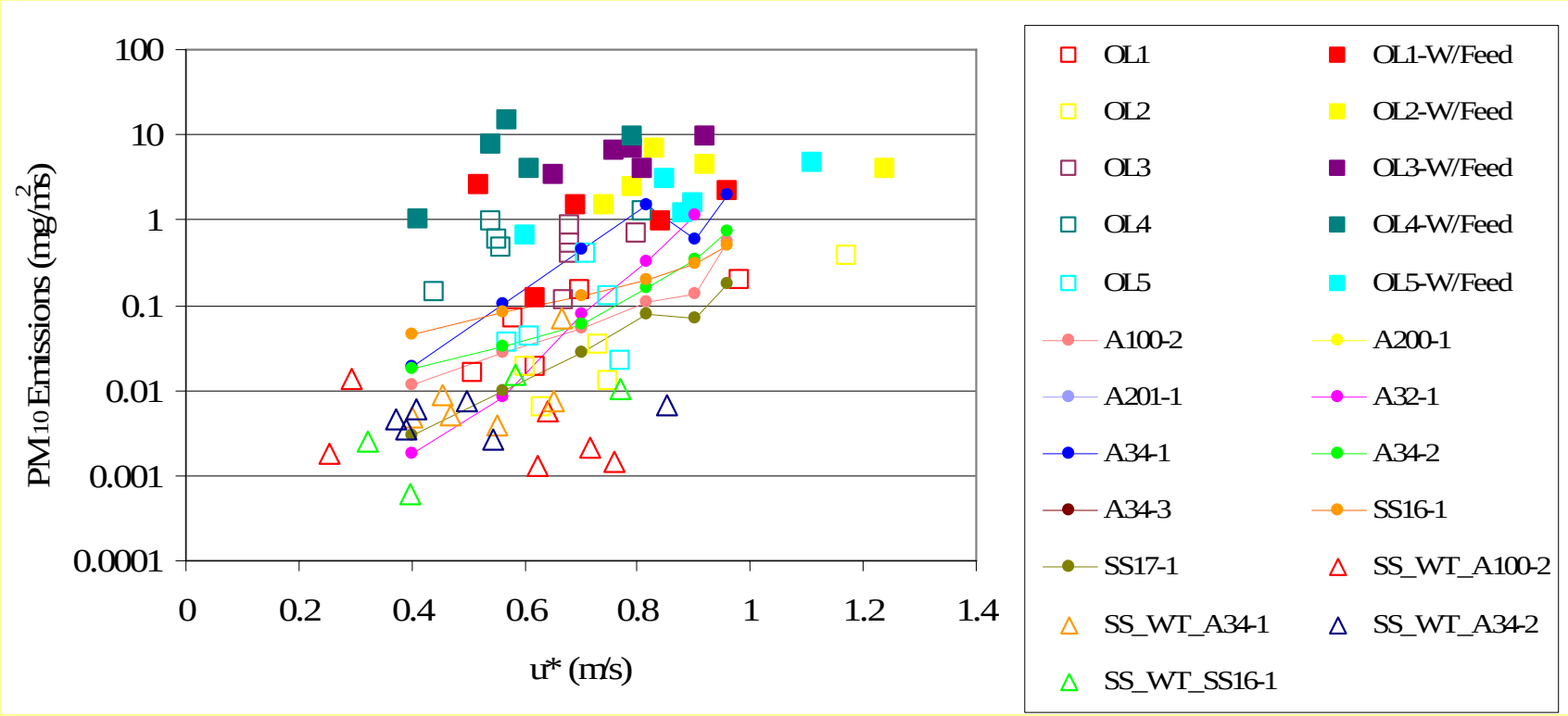
Roughness height z0 (m) /u* (m/s)		0.31	0.48	0.56	0.7	0.81
Min (A31-1)	m/s	13.1	20.4	23.7	29.7	34.3
4.30E-07	mph	29.3	45.4	53.0	66.2	76.6
Max (SS16-1)	m/s	7.5	11.6	13.6	17.0	19.6
6.20E-04	mph	16.7	25.9	30.2	37.8	43.8
Average	m/s	8.7	13.4	15.6	19.6	22.6
1.40E-04	mph	19.3	29.9	34.9	43.6	50.5

- 1 hour max winds around Salton Sea ~ 30 - 35 mph

Emissions by landform
$u_* = 0.56$ m/s

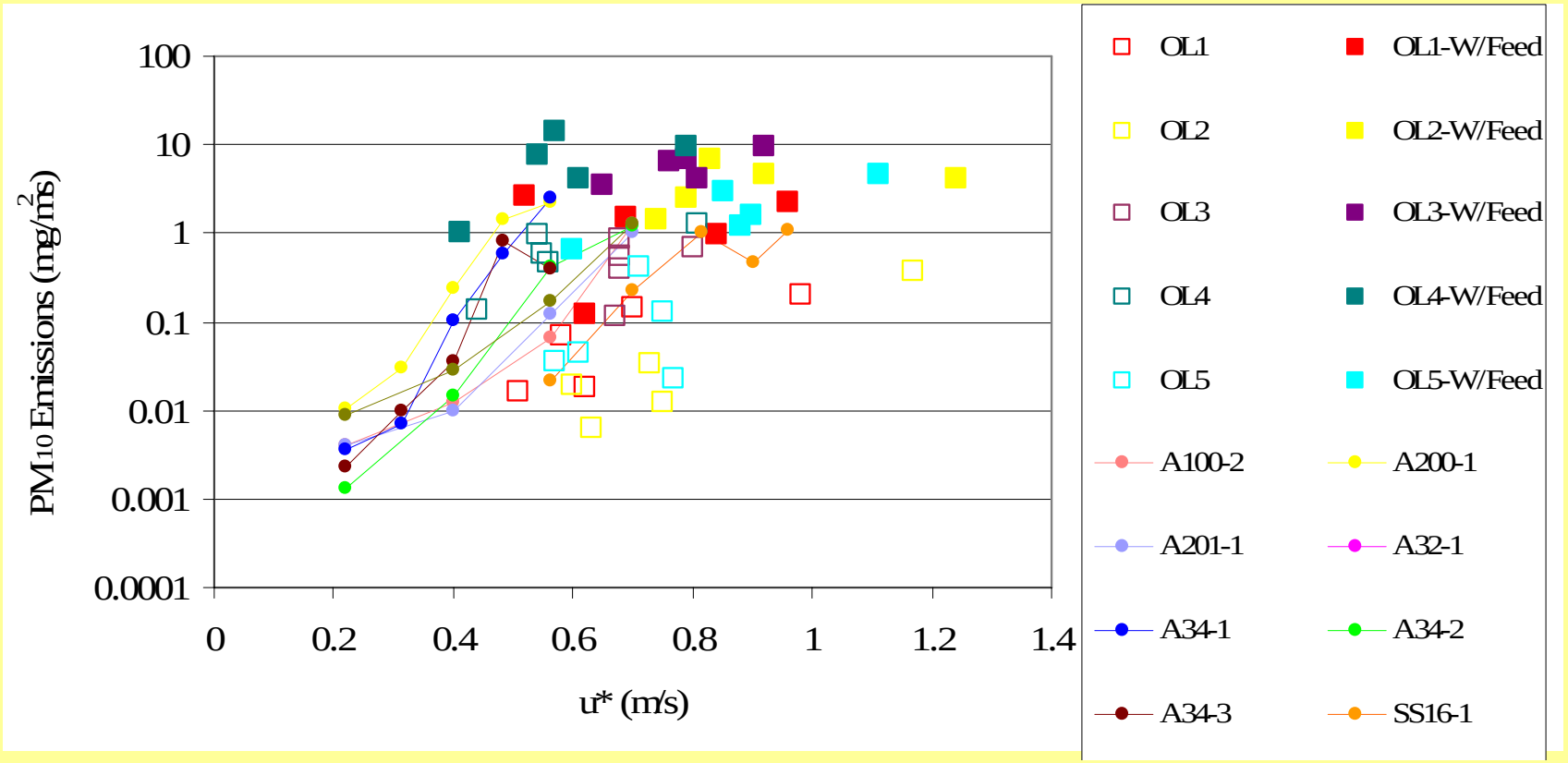


Comparison with data from Owens Lake (Nickling et al., 2001)



- September "playa-like" sites at Salton Sea compared to April/May 2000 at Owens Lake

Comparison with data from Owens



- January "playa-like" sites at Salton Sea compared to April/May 2000 at Owens

Differences in methods and likely influence on comparison

- Wind Tunnel dust emissions from Owens test quantified differently than Salton Sea
  - Effect: If same method used, Owens numbers would increase.
  - Net: Owens emissions > rel. graph
- Wind Tunnel data from Owens include artificial sand feed
  - Effect: If sand feed used at Salton Sea, emissions would increase over reported values. At many sites, sand feed would not affect already high emissions.
  - Net: SS emissions > rel. graph
- Wind Tunnel used at Owens, PI-SWERL used at SS
  - Effect: September data suggest PI-SWERL emissions for playas give higher estimates than wind tunnel w/o sand feed.
  - Net: If PI-SWERL used at Owens, Owens emissions > rel. graph
- Wind Tunnel at Owens in April and worst emissions at SS by PI-SWERL in January
  - Effect: Inherent soil emissivity at Owens probably worse in January
  - Net: Owens emissions > rel. graph
- Wind factor: wind speeds Owens in Jan-Mar > wind speeds at SS
  - Effect: If inherent soil emissivity is same at Owens and SS, lower winds at SS would give lower emissions
  - Net: Owens emissions > rel. graph

Summary

- Low elevation, fine-textured, “playa-like” soils appear to exhibit strong seasonality
  - Crusts weaker in winter
  - Emissions highest in winter
- Same applies to “barnacle beach” sites
- “Dry wash”, “paleo-lake”, and “interdune”, emissions are flat, but can be high
- Comparison of Salton Sea measurements to Owens Lake indicates preliminarily Salton Sea not likely to be as emissive as Owens Lake
  - Noting major differences in methodologies, this conclusion is very tentative

Important Considerations

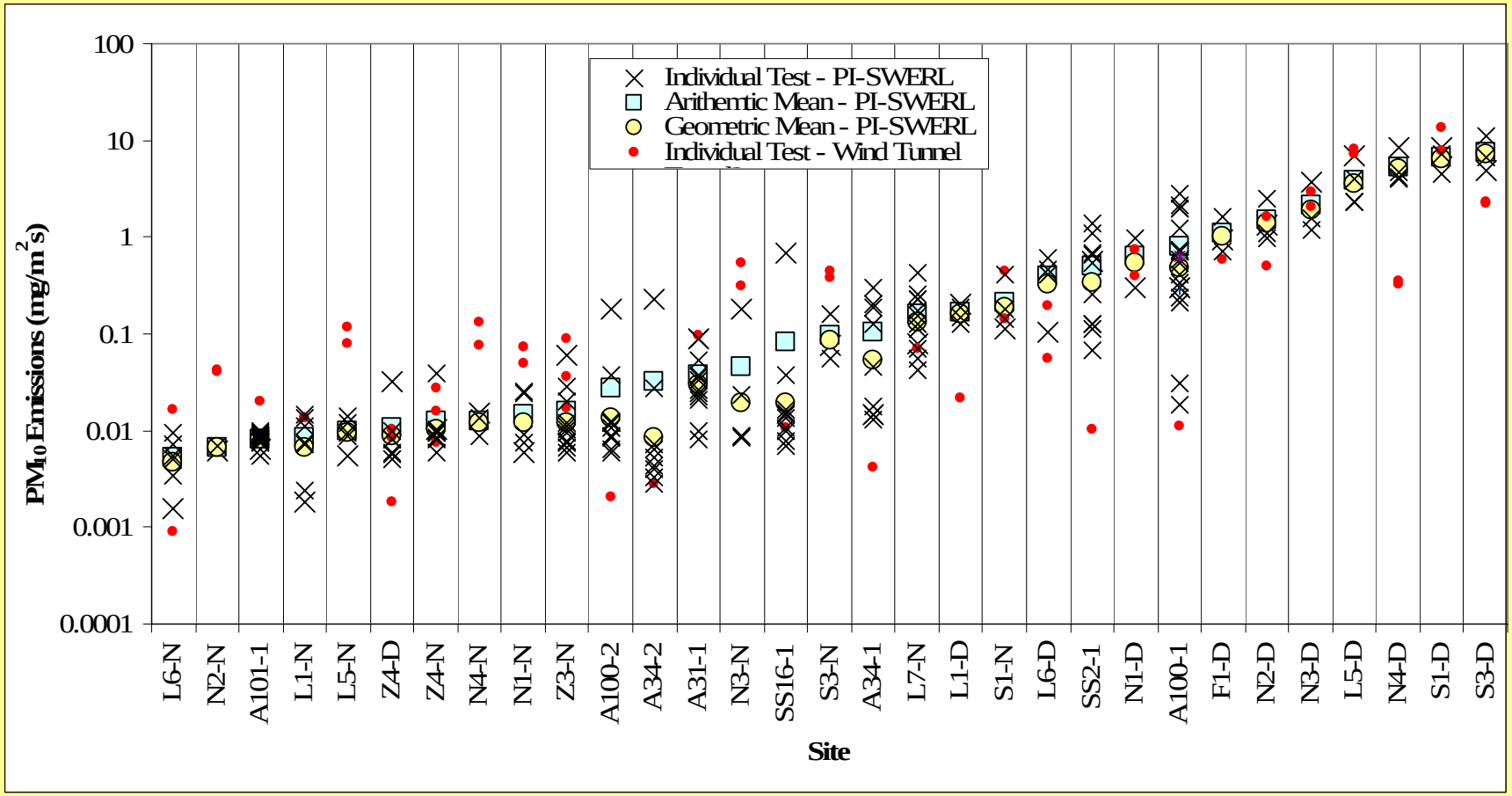
- All data presented based on shoreline measurements
  - Inundated sediments could exhibit different characteristics
- Entire study completed in 1 year
  - Year to year changes unknown
- One unstated conclusion
  - Significant variability exists even among shoreline samples. Salton Sea is not spatially homogeneous.

Considerations for Future Efforts

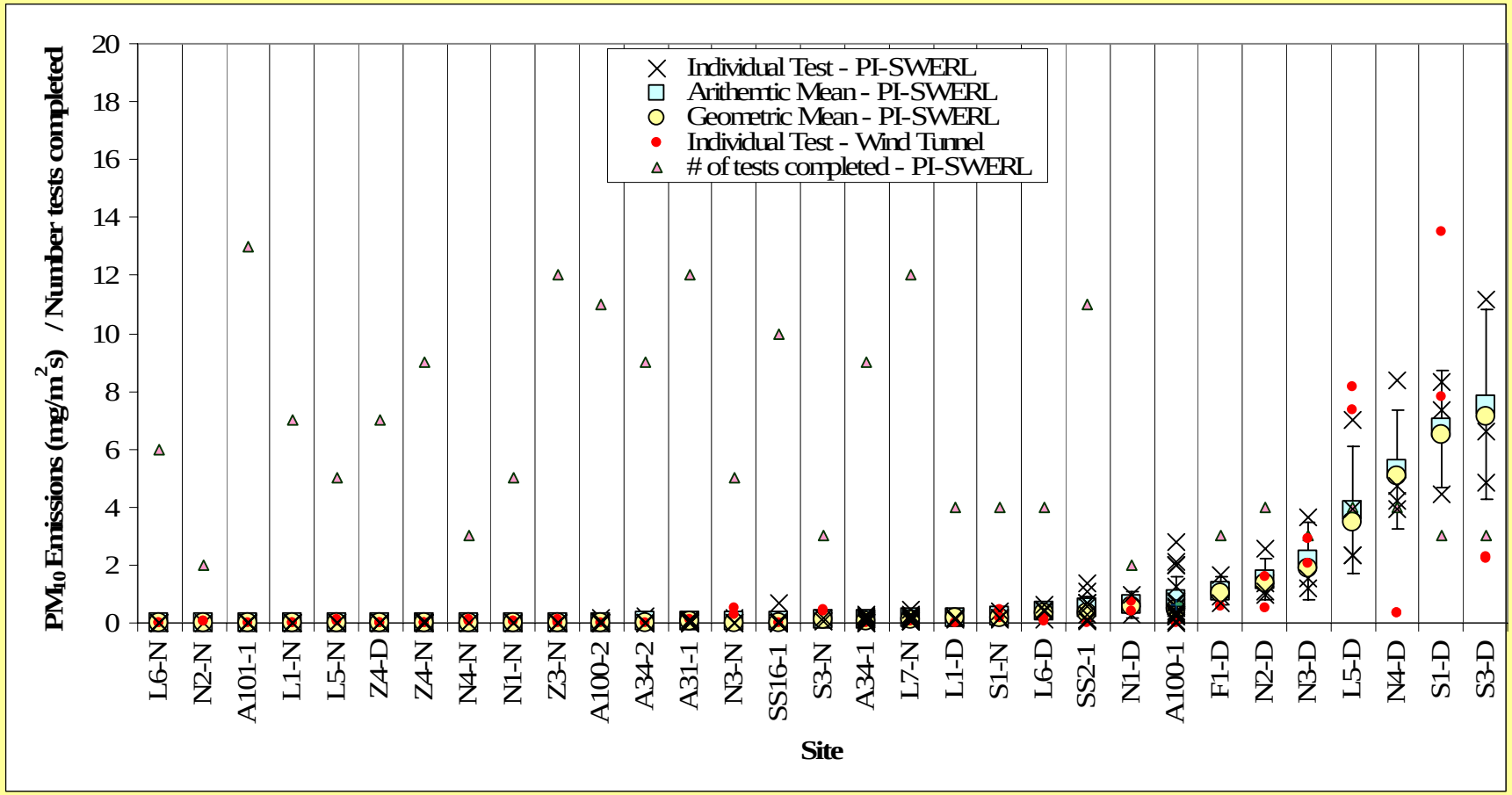
- Salt chemistry has huge role
  - Better handle on which salt minerals form under what conditions
- Year to year variations
- Movement of fine sediment from exposed areas over time
- Sand can be important. Where are likely sources of sand supply?

Supplemental

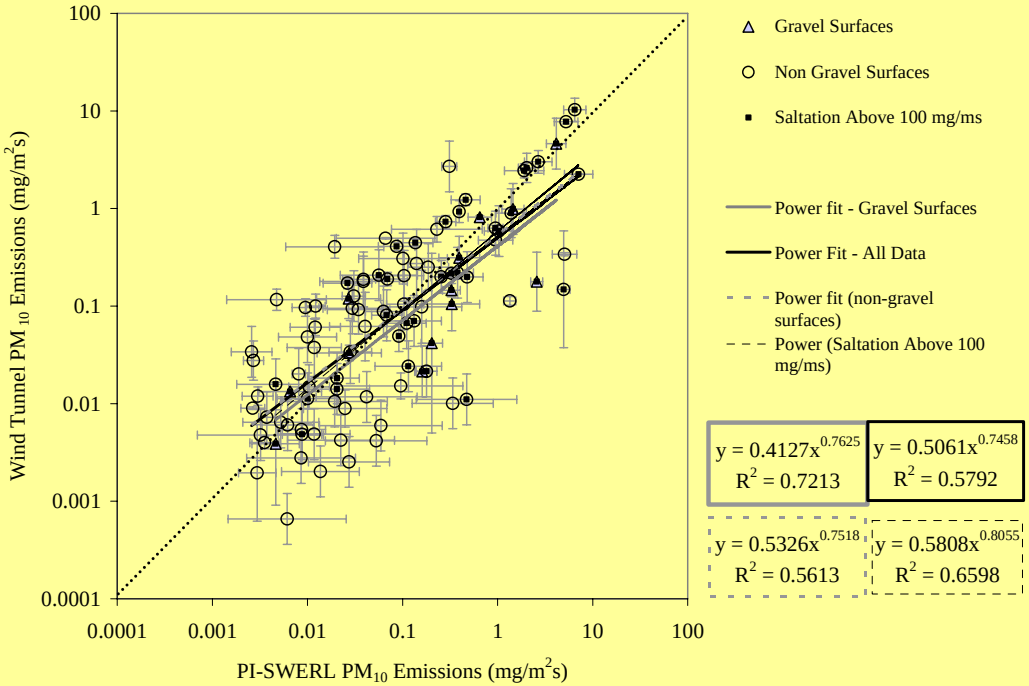
WT/PI-SWERL - Log



WT/PI-SWERL - Linear



WT/PI-SWERL



Gravel Surfaces

Non Gravel Surfaces

Saltation Above 100 mg/ms

Power fit - Gravel Surfaces

Power Fit - All Data

Power fit (non-gravel surfaces)

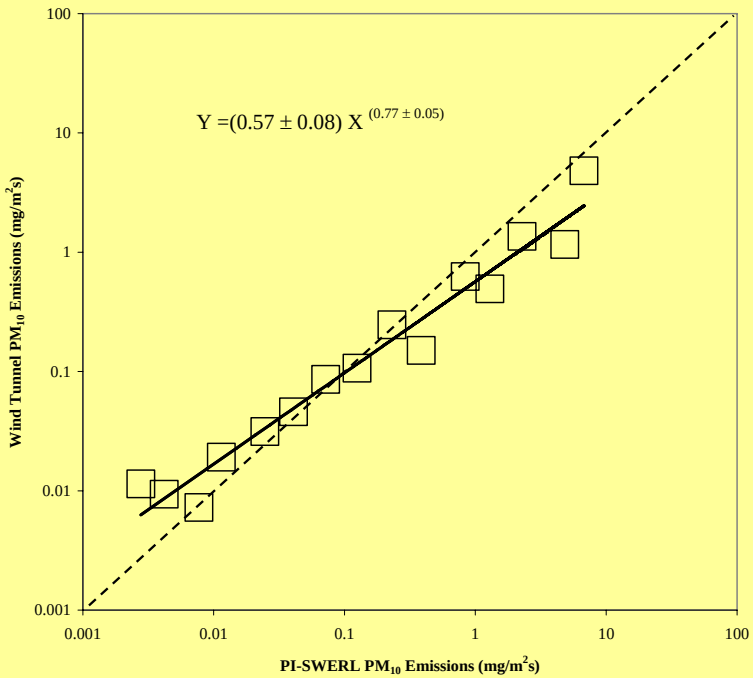
Power (Saltation Above 100 mg/ms)

$y = 0.4127x^{0.7625}$, $R^2 = 0.7213$

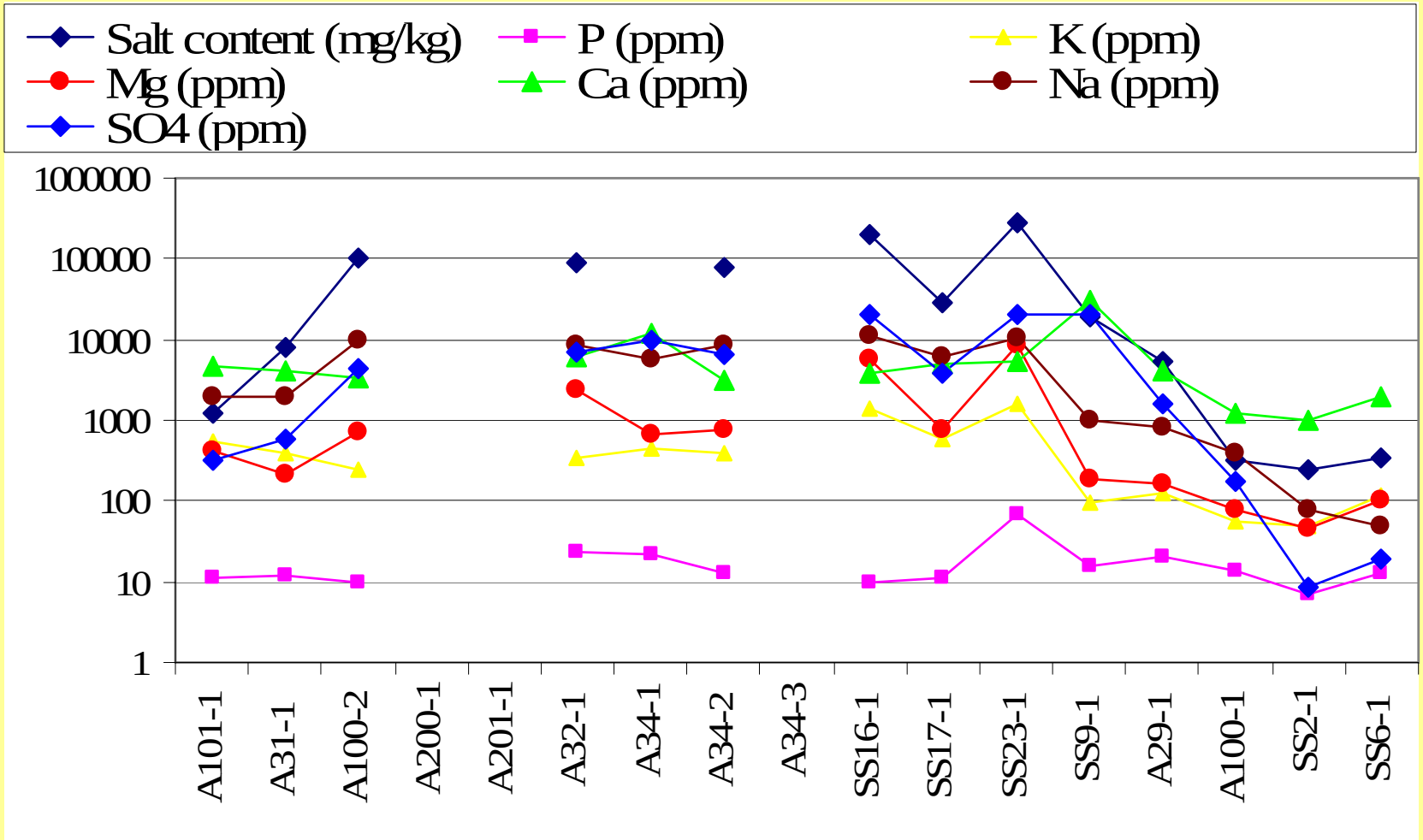
$y = 0.5061x^{0.7458}$, $R^2 = 0.5792$

$y = 0.5326x^{0.7518}$, $R^2 = 0.5613$

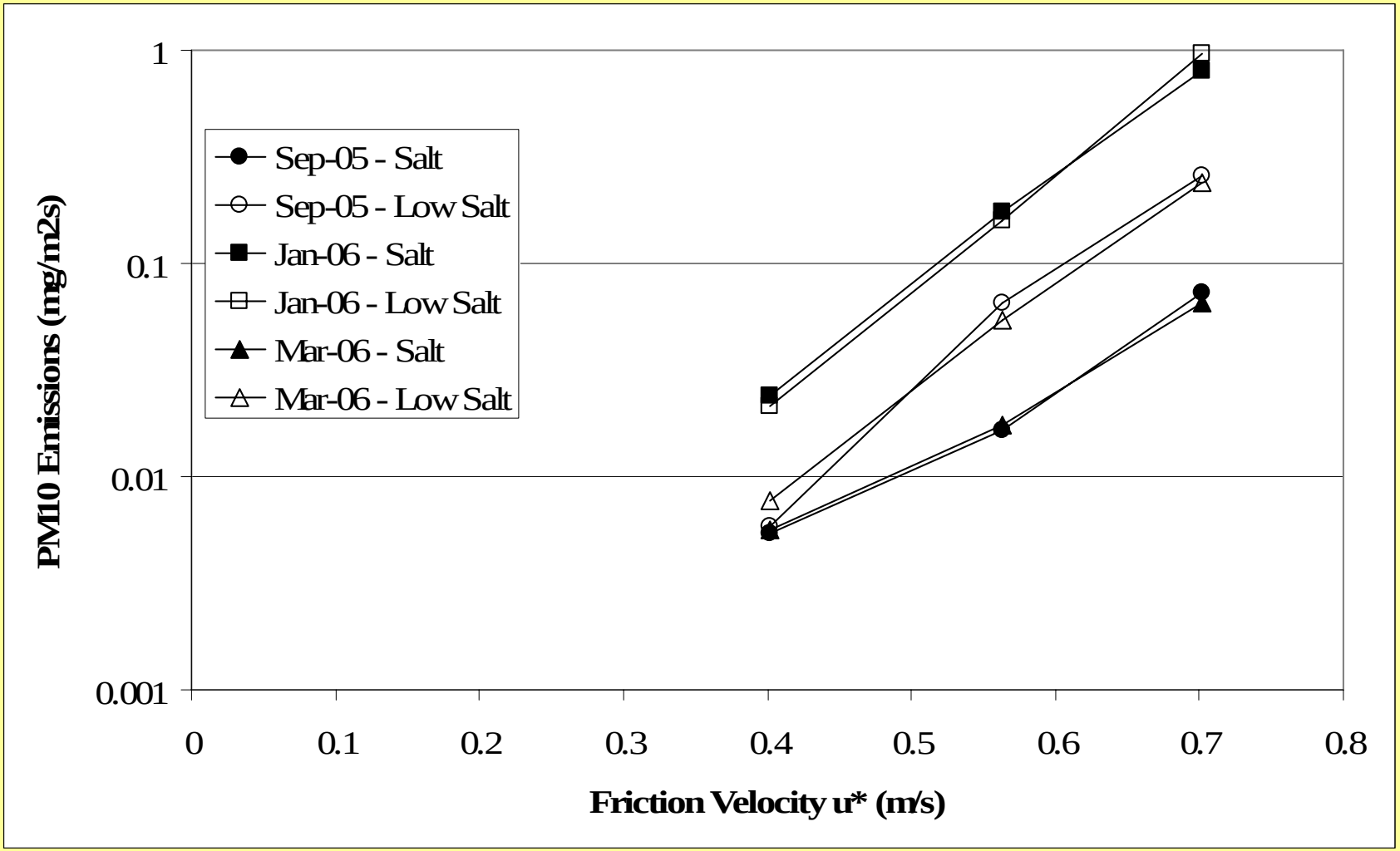
$y = 0.5808x^{0.8055}$, $R^2 = 0.6598$



Salt Content (Sep 05)



Salt/ No Salt


1
0.1
0.01
0.001
PM10 Emissions (mg/m2s)
Sep-05 - Salt
Sep-05 - Low Salt
Jan-06 - Salt
Jan-06 - Low Salt
Mar-06 - Salt
Mar-06 - Low Salt
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
Friction Velocity u* (m/s)